Received November 14, 1771.

LI. *An Account of the going of an Aſtronomical Clock: By the Rev.* Francis Wollaſton, *F. R. S.*

Read Dec. 19, 1771.

HAVING heard it often lamented, that very few regiſters of the going of clocks have been communicated to the public; I take the liberty to lay before the Society ſuch obſervations as I have made to aſcertain mine; and ſhall be happy if my amuſements can in any way be of the leaſt ſervice to any one.

My clock was made by Holmes. The pendulum rod is of deal, to which the ball is ſcrewed faſt; and it is adjuſted by a ſmaller weight underneath. The clock beats dead ſeconds; and is faſtened to a principal wall, independent of the floor. The room never has a fire in it.

The tranſit teleſcope, with which I made the obſervations, has an achromatic object glaſs, of only 14 inches focal length, and magnifies about 15 times; its tranſverſe axis is but 12 inches long, and it is mounted on a vertical axis of 18; being deſigned for an equal altitude inſtrument likewiſe, and ſo uſed

in ſome of the following obſervations. It is faſtened to a large ſtone pillar, bedded on the wall of the houſe; and is adjuſted in the meridian, to a mark 700 feet diſtant. I mention theſe particulars, becauſe the obſervations ſhew that even ſo ſmall an inſtrument is capable of tolerable exactneſs: and it is for that reaſon I have ſet down the reſult of all the tranſits I have taken for a year paſt; though much fewer would have ſufficed for ſhewing the rate of the clock. The obſervations themſelves are not here; becauſe I would not trouble the Society with ſuch a detail; elſe they ſhould readily have had them. It can be of no ſervice to falſify calculations, which might have been with-held; and I believe to the beſt of my abilities, theſe are done accurately. I am ſure they are delivered faithfully.

The 1ſt and 2d columns require no explanation.

The third ſhews how much the clock proved to be + or too faſt, — or too ſlow, for mean ſolar time upon each obſervation, when it came to be calculated afterwards. The marks : : or : are ſet down as any one appeared to me to be more or leſs doubtful at the time of obſerving. The calculations will ſhew which are really moſt to be ſuſpected.

The fourth column ſhews how much the clock varied per day, when compared with the preceeding obſervation of the ſame object. The ſmall variations in theſe, are owing probably to errors in obſerving, rather than to the clock itſelf. I do not pretend in obſerving to diſtinguiſh nearer than to half a ſecond; though the calculations are ſet down in decimals.

In

In the middle of February, when the firſt change was, the froſt was intenſe; and the pendulum did not, for ſome days, throw-out ſo far by about 7′ as it generally did; which was about 1° 37′ on one ſide, and 1° 40′ on the other. At the change in Auguſt, I obſerved no difference. It appears by theſe trials as if the clock gained in warm and loſt in cooler weather: but this is not clear. It began to gain before the weather grew warm. Whether this be owing to damp, or any other cauſes; longer experience and abler obſervers may diſcover.

1770		Clock + too fast — too slow	Varies from mean time per day
		′ ″	″
♃ Nov. 1	β Pegaſi	Cl. + 0,5	
	∝ Andromedæ	+ 0,5	
♀ 2	⊙ pr. eq. Alt. & Tr.	— 2,6	
⊙ 4	Fomalhaut	— 2,7	
	β Pegaſi	— 1,8	—0,8
♂ 13	⊙	: : —13,4	—1,0
	β Pegaſi	—10,0	—0,9
	∝ Andromedæ	—10,5	—0,9
♄ 17	⊙	—18,0	—1,1
	β Pegaſi	: —16,9	—1,7
	∝ Andromedæ	—16,9	—1,6
♂ 20	⊙	—21,5	—1,2
	β Pegaſi	—19,6	—1,0
	∝ Andromedæ	—21,2	—1,8
♄ 24	ε Pegaſi	—22,5	
	β Pegaſi	—21,5	—0,5
☽ 26	∝ ♒	—23,9	
♂ 27	γ Ceti	—24,4	
☿ 28	⊙	—25,6	—0,5
	∝ ♒	—25,7	—0,9
⊙ Dec. 16	γ Andromedæ	: : —51,	
♄ 22	Fomalhant	—1 6,4	—1,3
	β Pegaſi	—1 6,3	—1,6
⊙ 23	β Pegaſi	—1 7,4	—1,1
	γ Andromedæ	—1 6,3	
♂ 25	∝ Ceti	—1 14,0	
♃ 27	Rigel	—1 16,3	
	γ Orionis	: —1 15,9	
	δ Orionis	—1 17,3	
	ε Orionis	—1 17,0	
⊙ 30	∝ Andromedæ	: —1 22,2	
	β Andromedæ	—1 22,0	
1771			
⊙ Jan. 6	β Andromedæ	—1 37,5	—2,1
	γ Andromedæ	—1 37,5	—2,2
♂ 8	∝ Andromedæ	—1 40,5	—2,0
	β Andromedæ	—1 39,3	—0,8
	Rigel	—1 40,4	—2,0
☿ 9	⊙	: —1 43,3	
	β Andromedæ	—1 40,1	—0,8
	γ Andromedæ	—1 40,8	—1,1
	β Meduſæ	—1 41,	
	Rigel	—1 41,5	—1,1
♃ 10	γ Andromedæ	—1 41,9	—1,1

1771		Clock + too fast — too slow	Varies pr. day
		′ ″	″
♃ Jan. 10	Rigel	Cl.—1 43,7	—2,2
♀ 11	⊙	—1 44,2	—0,5
	β Andromedæ	—1 42,3	—0,8
⊙ 13	η Pleiadum	—1 45,6	
♂ 22	Rigel	—1 54,9	—1,0
♀ 25	Rigel	—2 0,7	—1,9
⊙ 27	γ Andromedæ	—2 1,3	—1,2
♀ Feb. 1	Rigel	—2 9,7	—1,3
⊙ 3	⊙ per equal Alt.	—2 12,	
☽ 4	⊙	:: —2 13,3	::—1,3
♂ 5	⊙	: —2 15,5	:—2,2
	η Pleiadum	—2 16,1	—1,3
	Rigel	—2 17,5	—1,9
♃ 7	Sirius	—2 19,3	
☽ 11	⊙	—2 17,0	—0,5
♂ 12	⊙	—2 15,5	+1,5
☿ 13	Sirius	—2 16,4	+0,5
♃ 14	⊙	—2 15,1	+0,2
	Rigel	—2 15,4	+0,2
	Sirius	—2 16,6	—0,2
⊙ 17	Sirius	—2 14,	+0,8
♄ 23	Rigel	—2 13,4	+0,2
♄ Mar. 9	Caſtor	—2 5,2	
	Procyon	—2 5,5	+1,7
⊙ 10	Caſtor	—2 3,5	:+1,2
	Procyon	: —2 4,3	+2,0
☽ 11	Procyon	—2 2,3	
☿ 13	∝ Orionis	—2 0,4	+1,1
	Caſtor	—2 0,2	+0,5
	Procyon	—2 1,3	+0,4
♀ 15	∝ Orionis	—1 59,6	:+0,5
	Sirius	: —2 0,1	:+0,5
	Procyon	: —2 0,5	+0,5
♄ 23	Sirius	—1 56,1	+0,5
	Procyon	—1 56,3	
⊙ 24	∝ Hydræ	—1 55,6	+0,6
☿ 27	⊙ per equal Alt.	—1 51,8	+1,4
♃ 28	∝ Hydræ	—1 50,1	+1,0
♄ 30	⊙ pr. eq. Alt. & Tr.	—1 48,8	+0,8
⊙ 31	Sirius	—1 49,8	+0,3
☽ Apr. 1	⊙	—1 48,2	+0,4
	Sirius	—1 49,4	±0,0
♂ 2	⊙	—1 48,2	+1,4
	Sirius	—1 48,0	

1771		Clock + too fast — too flow	Varies from mean time per day
		′ ″	″
♂ Apr. 2	Procyon	Cl.—1 48,4	+0,8
	α Hydræ	—1 48,3	+0,4
☿ 3	☉	: —1 47	+1,2
♀ 5	☉	—1 45,3	+0,9
☽ 8	☉	—1 43,7	+0,5
	Sirius	—1 43,5	+0,7
	Procyon	—1 44,3	+0,7
♂ 9	☉	—1 41,7	+2,0
	Sirius	—1 42,4	+1,1
	Procyon	—1 42,4	+1,9
♃ 11	☉	—1 38,5	+1,6
	Sirius	—1 39,5	+1,4
♄ 13	☉	—1 37,5	+0,5
	α Hydræ	—1 37,5	+1,0
☿ 17	☉	—1 30,0	+1,9
♀ 19	Regulus	: —1 26,4	
♄ 20	☉	—1 25	+1,7
♃ 25	β ♌	—1 19,4	
♄ 27	☉ pereq. Alt. & Tr.	—1 16,2	+1,3
☉ May 5	β ♌	— 59,5	+2,0
☉ 12	β ♌	— 47,6	+1,7
☽ 13	β ♌	— 45,4	+2,2
♃ 16	β ♌	: — 42,4	+1,0
	Spica ♍	— 40,9	
♄ 18	Spica ♍	— 38,6	+1,2
☉ 19	Spica ♍	— 36,2	+2,4
♂ 21	☉	— 34,0	+1,8
	Spica ♍	— 33,4	+1,4
♀ 24	☉	— 27,8	+2,0
☽ 27	Spica ♍	— 19,8	+2,3
	Arcturus	— 20,9	
	β ♏	— 19,6	
♂ 28	Arcturus	— 18,3	+2,6
☿ 29	☉	— 15,4	+2,5
♄ June 1	Spica ♍	— 5,5	+2,9
☉ 2	Arcturus	— 3,2	+3,0
	γ Bootis	— 3,0	
☿ 5	☉	+ 5,3	+2,9
♄ 8	☉	+ 13,2	+2,6
	Spica ♍	+ 14,1	+2,8
☽ 10	☉	+ 18,0	+2,4
♂ 18	☉	+ 35,0	+2,1
	Antares	+ 36,1	

1771		Clock + too fast — too flow	Varies pr. day
		′ ″	″
♃ June 20	α Coronæ	Cl. + 38,4	
♀ 21	☉	+ 39,7	+1,6
	α Coronæ	+ 39,3	+0,9
	Antares	+ 39,3	+1,1
♄ 22	☉	+ 40,6	+0,9
♂ 25	☉	+ 45,4	+1,4
	Antares	: + 45,5	+1,5
	α Ophiuchi	+ 46	
♃ 27	☉	+ 47,75	+1,2
♄ 29	☉	+ 51,2	+1,7
	Arcturus	+ 51,0	
	Antares	+ 51,6	+1,5
♂ July 2	☉	+ 56,8	+1,9
☿ 3	Antares	+ 58,7	+1,8
♀ 5	☉	: + 1 0,2	+1,1
☉ 21	α Ophiuchi	+ 1 30,9	+1,7
☽ 22	α Ophiuchi	+ 1 32,8	+1,9
♂ 23	β Lyræ	+ 1 34,3	
☿ 24	☉	+ 1 35,1	+1,8
♄ 27	☉	: + 1 40,8	+1,9
☽ 29	α Lyræ	+ 1 47,7	
♃ Aug. 1	☉	+ 1 52,0	+2,2
♄ 3	α Aquilæ	: + 1 58,1	
☉ 4	α Lyræ	+ 1 59,2	+1,9
	α Aquilæ	+ 1 59	+0,9
☽ 5	☉	+ 2 0,3	+2,1
	α Lyræ	+ 2 1,1	+1,9
♂ 6	α Lyræ	+ 2 3,0	+1,9
☿ 7	☉	:: + 2 3,9	+1,8
♃ 8	α Lyræ	+ 2 6,9	+1,9
♀ 9	☉	+ 2 7,2	+1,7
♄ 10	☉	: + 2 9,0	+1,8
	α Lyræ	+ 2 9,7	+1,4
♃ 15	☉	: + 2 18,9	+2,0
♀ 16	α Aquilæ	+ 2 20,9	+1,8
♄ 17	☉	+ 2 20,3	+0,7
	α Lyræ	+ 2 21,3	+1,7
	α Aquilæ	+ 2 21,8	+0,9
☽ 26	☉	+ 2 26,1	+0,6
♂ 27	☉	+ 2 25,5	−0,6
	α Lyræ	+ 2 26,4	+0,5
♃ 29	α Aquilæ	+ 2 25,7	+0,3
♀ 30	☉	+ 2 26,1	+0,2

1771			Clock + too fast — too slow	Varies from mean time per day
			′ ″	″
♀ Aug.	30	♂ ♍	Cl. +2 24,7	
♄	31	☉	+2 24,3	Cl. —1,8
☽ Sept.	9	α Aquilæ	:: +2 27	
		β Aquilæ	+2 25,5	
		α ♍ 2	+2 25,5	
		β ♍	+2 25,6	
♂	10	α ♍ 2	+2 25,4	—0,1
		β ♍	+2 25,5	—0,1
♃	12	☉	+2 25,0	
♄	14	☉	:: +2 22,6	:: —1,2
		α Lyræ	: +2 22,8	—0,2
		γ Aquilæ	: +2 22,9	
☉	15	☉ Equal Alt.	:: +2 20,4	
		α Aquilæ	+2 22,4	—0,2
☽	16	β ♒	+2 21,5	
		γ ♍	+2 21,1	
		Fomalhaut	+2 21,5	
♂	17	☉ per Tranſit	+2 20,9	
		per equal Alt.	+2 20,5	
☿	18	β ♍	+2 19,8	—0,7
♃	19	☉ pr.eq.Alt.& Tr.	+2 19,0	—0,9
		γ Aquilæ	+2 18,4	—0,9
		α Aquilæ	+2 18,7	—0,9
		β ♍	+2 18,7	—1,1
♀	20	α Lyræ	+2 17,9	—0,8
		α Aquilæ	+2 18,1	—0,6
♄	21	☉	: +2 16,1	: —1,4
		γ Aquilæ	+2 16,3	—1,1
		α Aquilæ	+2 17,0	—0,8
☿	25	β ♒	+2 13,7	—0,8
		γ ♍	+2 14,1	—0,8
♀	27	☉	+2 12,0	—0,7
♄	28	☉	+2 11,9	—0,1
☽	30	η Pegaſi	+2 11,6	
♂ Oct.	1	☉	+2 11,1	—0,3

1771			Clock + too faſt — too ſlow	Varies pr.day
			′ ″	″
♂ Oct.	1	α ♍ 2	Cl. +2 10,7	—0,7
☿	2	☉	+2 10,3	—0,8
		α Lyræ	+2 11,6	—0,5
		α Aquilæ	+2 11,6	—0,6
♀	4	☉	+2 11,3	+0,5
		α Aquilæ	+2 11,4	—0,1
		Fomalhaut	+2 10,9	—0,4
♄	5	☉ pr.equal Alt.	+2 10,9	—0,4
♃	10	☉	+2 7,4	—0,7
		γ Aquilæ	+2 7,5	—0,5
		α Aquilæ	+2 7,4	—0,7
♀	11	☉	+2 6,6	—0,8
		γ Aquilæ	+2 6,6	—0,9
		α Aquilæ	+2 6,8	—0,6
♄	12	☉	: +2 6,7	:+0,1
		γ Aquilæ	+2 6,3	—0,3
		α Aquilæ	+2 6,4	—0,4
☽	14	γ Aquilæ	+2 4,6	—0,9
		α Aquilæ	+2 4,3	—1,0
		γ ♍	+2 4,6	—0,5
♂	15	γ ♒	+2 3,4	
☿	16	☉	+2 2,4	—1,0
		α Lyræ	+2 2,1	—0,7
♀	18	☉	: +1 59,9	—1,2
☽	21	☉	+1 55,3	—1,5
♀	25	☉	+1 47,5	—1,1
♄	26	☉	+1 46,4	—1,9
		γ Aquilæ	+1 46,5	—1,5
		α Aquilæ	+1 46,7	—1,5
♂	29	☉	: +1 40,4	—2,0
☿	30	γ Aquilæ	+1 39,1	—1,8
		α Aquilæ	+1 39,3	—1,8
♃	31	β Pegaſi	+1 38,1	

From theſe Obſervations it appears that the rate of the clock was as follows.

1770		Clock + too faſt —too ſlow	Grain or Loſs	Numb. of Days	Rate per Day
		′ ″	″		″
Nov.	1	+ 0,5	—17,4	16	—1,1
	17	— 16,9	— 8,8	11	—0,8
	28	— 25,7	—40,7	24	—1,7
Dec.	22	—1 6,4	—15,6	8	—1,9
	30	—1 22.0			
1771			—23,6	14	—1,7
Jan.	13	—1 45,6	—24,1	19	—1,3
Feb.	1	—2 9,7	— 5,7	13	—0,4
	14	—2 15,4	+10,1	23	+0,4
March	9	—2 5,5	+ 5,5	6	+0,9
	15	—2 0,0	+10,6	17	+0,6
April	1	—1 49,4	+11,9	12	+1,0
	13	—1 37,5	+38,0	22	+1,7
May	5	— 59,5	+20,9	13	+1,6
	18	— 38,6	+33,1	14	+2,4
June	1	— 5,5	+41,6	17	+2,4
	18	+ 36,1	+22,6	15	+1,5
July	3	+ 58,7	+32,2	18	+1,8
	21	+1 30,9	+26,2	13	+2,0
Aug.	3	+1 57,1	+23,8	13	+1,8
	16	+2 20,9	+ 3,8	14	+0,3
	30	+2 24,7	— 2,3	16	—0,1
Sept.	15	+2 22,4	—11,7	16	—0,7
Oct.	1	+2 10,7	— 7,3	14	—0,5
	15	+2 3,4	—25,3	16	—1,6
	31	+1 38,1			

I will here add a few other obſervations I have made ſince I ſettled in this place, the lat. of which is 51° 24′ 33″ North, and the long. is 18,″5 in time, Eaſt of the Obſervatory at Greenwich.

Occultations of ſtars by the Moon.

1770				App. time	
♄ Apr.	7	e	♌	Imm. 11 29 25	obſerved with a 12 inch reflector.
♄	28	ζ	♓	Imm. 9 51 56;	windy and doubtful; ſame teleſc.

1771

♂ June 18 The Moon's lower limb juſt covers a ſmall ſtar. The imm. on the dark part, to which the ſtar ſeemed to adhere above two minutes; and, though not at all diſcoloured, loſt a little of its brightneſs, but diſappeared at laſt inſtantaneouſly, Apparent time 10 1 49
The Em. on the light part and doubtful 10 10 46
Obſerved with a 3½ feet achrom. magnifying 100 times.

♂ July 23 2 ♑ ☿ I believe
Imm. 10 41 36,5 certain 3½ achrom. mag. 150
Em. 11 43 27 :: doubtful

☿ Sept. 18 * ♍ Imm. 11 56 51 good
β ♍ Imm. 12 2 47 good } 3½ achrom. mag. 150
The emerſions not till after the Moon was ſet.

Eclipſes of Jupiter's Satellites.

		App. time		
1770				
♀ July	13	9 6 24	Firſt Sat. Em.	12 In. Reflector mag. 55
♄	21	9 3 8::	Fourth Sat. Imm.	Ditto
		9 57 43::	Em.	
☉ Aug.	5	9 20 42	Firſt Sat. Em.	Ditto
☉	28	9 43 3::	Firſt Sat. Em. ♃ near ☽	Ditto
☿	29	9 1 41	Second Sat. Em.	Ditto

		App. time		
1771				
☽ July	22	8 46 20::	Second Sat. Em. cloudy	3½ Achrom. mag. 100
♃ Aug.	1	9 8 5::	Third Sat. Em. cloudy	3½ Achrom. mag. 100
		10 30 54::	Firſt Sat. Em. cloudy	3½ Achrom. mag. 100
♄	17	8 51 9	Firſt Sat. Em.	12 Inch Refl. mag. 35
♂	27	9 32 3	Fourth Sat. Imm. hazy	3½ Achrom. mag. 100
♀	30	11 3 20	Second Sat. Em.	Ditto
☽ Sept.	9	9 12 18	Firſt Sat. Em.	Ditto
☽	16	11 11 15:	Firſt Sat. Em. ♃ but 3° 30′ high	Ditto
☿ Oct.	2	9 35 56	Firſt Sat. Em.	Ditto
♀	11	6 3 16	Firſt Sat. Em.	Ditto
♄	26	6 14 25	Third Sat. Imm.	Ditto
		8 4 16	Second Sat. Em.	Ditto

Chiſlehurſt, Nov. 2, 1771.

Francis Wollaſton.

LII. *An*